

Hydrology of Agate Fossil Beds

National Monument

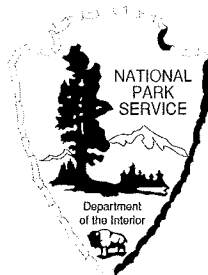
Nebraska

Technical Report NPS/NRWRD/NRTR-2005/327

**Larry Martin
Hydrogeologist**

**Water Resources Division
1201 Oakridge Drive, Suite 250
Fort Collins, CO 80525**

February 2005



The National Park Service Water Resources Division is responsible for providing water resources management policy and guidelines, planning, technical assistance, training, and operational support to units of the National Park System. Program areas include water rights, water resources planning, regulatory guidance and review, hydrology, water quality, watershed management, watershed studies, and aquatic ecology.

Technical Reports

The National Park Service disseminates the results of biological, physical, and social research through the Natural Resources Technical Report Series. Natural resources inventories and monitoring activities, scientific literature reviews, bibliographies, and proceedings of technical workshops and conferences are also disseminated through this series.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

Copies of this report are available from the following:

National Park Service	(970) 225-3500
Water Resources Division	
1201 Oakridge Drive, Suite 250	
Fort Collins, CO 80525	

National Park Service	(303) 969-2130
Technical Information Center	
Denver Service Center	
P.O. Box 25287	
Denver, CO 80225-0287	

Hydrology of Agate Fossil Beds
National Monument
Nebraska

Technical Report NPS/NRWRD/NRTR-2005/327

Larry Martin
Hydrogeologist

Water Resources Division
1201 Oakridge Drive, Suite 250
Fort Collins, CO 80525

February 2005



Table of Contents

	Page
Physical Setting.....	1
Water Use in Wyoming and Interstate Compact	1
Streamflow Gage at Wyoming-Nebraska Border.....	2
Water Use Between the Wyoming-Nebraska Border and Agate	2
Streamflow Gage at Agate	3
Water Use at Agate Fossil Beds.....	3
Water Use Immediately Downstream of the park	4
Water Quality.....	5
Geology and Groundwater Resources	5
Issues.....	7
Streamflow gaging	7
Water table decline from groundwater pumping	7
Groundwater/surface water interaction.....	8
References.....	8

Figures

1. Location of Agate Fossil Beds National Monument in western Nebraska.
2. Map of Agate Fossil Beds National Monument.
3. Location of surface water diversions from the Niobrara River.
4. Location of registered water wells along the Niobrara River.
5. Streamflow in the Niobrara River during the period the gaging station was operated by NPS personnel.
6. Rating Curve for streamflow gaging station on the Niobrara River at Agate, Nebraska.
7. Well locations at Agate Fossil Beds National Monument.
8. Average daily water use at the visitor center and museum.
9. Depth to groundwater measured in the potable supply well in the maintenance area.

Tables

1. Surface Water Rights on the Niobrara River from the Wyoming-Nebraska state line through Agate Fossil Beds National Monument.
2. Streamflow and Irrigation Diversions from the Niobrara River, acre-feet.
3. Registered Groundwater Wells within about 1 mile of the Niobrara River from the Wyoming-Nebraska state line to downstream of Agate Fossil Beds National Monument.

Appendices

1. Reconnaissance survey of the geology and ground-water resources of the proposed Agate Fossil Beds National Monument, Sioux County, Nebraska, May 31, 1966.
2. Memo describing construction of Well #1, July 19, 1968.
3. Memo and Responses; Water questions from Agate Fossil Beds National Monument, May 9, August 27, October 10, and October 23, 1986.
4. Driller's logs and well driller's report for the domestic supply well and the fire supply well constructed in October 1992 at the maintenance area.
5. Memo, Flow measurement of the Niobrara River within Agate Fossil Beds National Monument, August 8, 2002.
6. Description of "Geologic Formations" and "Rivers and Streams" from the monument's website: www.nps.gov/agfo.
7. Hydrographs of streamflow in the Niobrara River at Agate, Nebraska; USGS data from 1957-91.
8. Streamflow records for the Niobrara River at Agate, Nebraska, 1995-2004.

Executive Summary

Agate Fossil Beds National Monument is in central Sioux County, in northwestern Nebraska, on the western edge of the Sand Hills. Water resources at Agate Fossil Beds are dominated by the Niobrara River, which flows from west to east through the middle of the park.

Surface water diversions from the Niobrara River and groundwater pumping provide water for irrigation and municipal use upstream of the park in Nebraska and Wyoming. Locations of surface water diversions and irrigation wells are shown on maps and estimates of irrigated acreage along the Niobrara River upstream of the park are tabulated and summarized.

Streamflow in the Niobrara River has been gaged at the upstream (west) side of the park since 1957. The gaging station has been operated by the USGS, NPS, and Nebraska DNR. Previously unpublished streamflow data for the period when NPS personnel operated the streamflow gage (1995-2004) are included in the appendices.

Water for potable use, irrigation, and fire protection at the park is obtained from wells. Annual usage for all facilities at the park is about 2,500,000 gallons, or 7.7 acre-feet.

Most of the water quality data that are available for the park are associated with the Long Term Ecological Monitoring (LTEM) macroinvertebrate monitoring program and are from sampling locations near the streamflow gaging station at the Highway 29 bridge on the west side of the park. The NPS Northern Great Plains Network is developing a new monitoring plan for aquatic ecosystems at the park.

Previous geologic and hydrologic reports, letters, and memos are included in the appendices of this report.

Hydrology of Agate Fossil Beds National Monument, Nebraska

Physical Setting

Agate Fossil Beds National Monument is in central Sioux County, in northwestern Nebraska, on the western edge of the Sand Hills (Figure 1). The park is in the Niobrara River Valley about 40 miles north of Scottsbluff. The park preserves a unique unglaciated area of the High Plains. Wetlands stretch out from the river and meet terraces that lead to breaks and buttes. The buttes contain fossil remains, providing important information about the life of mammals in the Miocene Era, 19-22 million years ago.

Agate Fossil Beds National Monument is a small park unit with only 2,700 acres of federally managed land included in the 3050 acres within the park boundary (Figure 2). Once part of "Captain" James H. Cook's Agate Springs Ranch, the nearby beds are an important source for Miocene epoch mammal fossils. Cook's ranch was also a gathering place for Chief Red Cloud and other Oglala Lakota (Sioux) Indian people.

Water resources at Agate Fossil Beds are dominated by the Niobrara River, which flows from west to east through the middle of the park. Groundwater in the alluvium adjacent to the river is closely interconnected with surface water in the river. The alluvium is a buffer to streamflow, accepting recharge during periods of high streamflow and slowly releasing the water from storage during periods of low streamflow.

Water Use in Wyoming and Interstate Compact

The Niobrara River has its headwaters in eastern Wyoming. The river drains about 450 square miles in Wyoming, mostly in southeastern Niobrara County around the Lusk area. The Upper Niobrara River Compact was signed by Nebraska and Wyoming in 1962. This agreement placed limitations on reservoir construction and direct use of surface water for irrigation in Wyoming. Groundwater development is recognized to be a significant factor of the hydrologic regime and the compact provides for investigation of this resource and possible apportionment at a later date. No apportionment of groundwater has yet occurred under this compact.

Water use in the Niobrara River Basin in Wyoming includes irrigation of 15,000 acres from groundwater sources and 1000 acres from surface water sources, consuming about 16,000 acre-feet/year. Municipal use in the communities of Manville, Lusk, and Van Tassel consumes about 120 million gallons per year (370 acre-feet) (HKM Engineering, et.al., 2002).

Streamflow Gage at Wyoming-Nebraska Border

A streamflow gage has been operated on the Niobrara River near the Wyoming-Nebraska border since 1955. The USGS operated the gage until October 1, 1994. Records for the period from 1955-94 are available from the USGS databases. Nebraska DNR took over operation of the station in October 1994. Shortly thereafter the measuring point was moved downstream 0.4 mile, 0.1 mile downstream of the Wyoming-Nebraska State Line. Streamflow records after October 1, 1994 are available from Nebraska DNR and are published in DNR's annual Hydrographic Report.

Water Use Between the Wyoming-Nebraska Border and the Park

Records for diversion of surface water from the Niobrara River were obtained by searching the Nebraska DNR website (<http://www.nrc.state.ne.us/docs/surface.html>). There are 11 water rights for diversion of from the Niobrara River between the Wyoming-Nebraska border and Agate Fossil Beds (Table 1). These rights allow diversion of water to irrigate 1900 acres.

The Harris-Neece Canal diverts water from the river immediately downstream of the park. This ditch is permitted for diversion of water to irrigate 676 acres.

Locations of surface water diversions are shown on the map in Figure 3. The amount of water diverted annually for each ditch is reported in DNR's annual Hydrographic Report. Diversions from the Niobrara River for 1995-2003 are shown in Table 2.

These data do not account for return flow or groundwater discharge to the river. As the river flows downstream, groundwater discharge to the river increases flow. Otherwise, simple math would show that there is not enough flow crossing the state border to provide the amount of water diverted above, and immediately below, the Park.

The Nebraska DNR website (<http://www.nrc.state.ne.us/docs/groundwat.html>) was searched to identify irrigation wells within about 1 mile of the Niobrara River. This distance was chosen as the probable maximum distance that an irrigation well might have an influence on flow in the river. A total of 16 wells were identified upstream of the park (Table 3 and Figure 4). These wells are permitted to irrigate a total of 1600 acres. Immediately downstream of the park, two more irrigation wells are permitted for irrigation of 260 acres.

Streamflow Gage at Agate

The USGS operated a streamflow gaging station on the Niobrara River just upstream of the Highway 29 bridge from 1957-91 (Station Number 06454100). Park staff have continued to operate the chart recorder at the site since 1991. The record since 1991 is not continuous because there were many times when the recorder was not functioning properly. Hydrographs showing the streamflow for the periods when the recorder was functioning properly are shown in Figure 5. Annual hydrographs showing more detail for each year are included in the appendices of this report.

In 2002-03, USGS personnel made several streamflow discharge measurements to check the validity of the rating curve for the site. Data collected in 2002-03 are shown on Figure 6 along with the rating curve that was used prior to 1991. The data from 2003-03 show that the rating curve is still a fairly reliable tool for converting stage (water level) in the stream to flow rates.

In fall of 2004, Nebraska DNR staff installed a datalogger and began operation of a streamflow gaging station at the site. The datalogger was purchased by NPS. Nebraska DNR staff will make regular measurements of streamflow, collect and analyze data, and publish the mean daily streamflow at the site in DNR's annual Hydrographic Report.

Water Use at Agate Fossil Beds

The location of water supply wells at the park is shown on Figure 7.

Prior to 2005, potable water for visitors to the park was provided from a 240-foot deep well located north of the main road, across from the Visitor Center and Museum. The well was tested at a rate of 160 gpm for 30 hours at the time of construction (1967). The water was of good quality and was chlorinated as a standard precaution. Water for four park staff houses in the eastern housing area and the maintenance shop was provided from a 180-foot deep well near the maintenance shop. Water was pumped to pressure tanks in the maintenance shop and then sent out through the distribution system.

In the winter of 2004-05, the water system was rehabilitated and upgraded to create a safer, more efficient system that is not susceptible to disruptions from power outages. The new system utilizes the domestic supply well in the maintenance area as the primary source. A new water line was constructed from the well to the storage tank. The distribution system from the storage tank was expanded to interconnect all facilities at the Visitor Center and Museum, the eastern housing area, and the maintenance shop. This system also provides irrigation water for lawns. The fire supply well provides the backup supply. The

old visitor center well (Figure 7) was maintained as a monitoring well, but the well house and all the associated equipment were removed.

Water for fire suppression is provided from a large volume well (300 gpm) near the maintenance shop.

Water for the Hoffman House (staff housing on the south side of the river) is provided from a well next to the house. This well was repaired in 2003. A new pump and drop pipe were installed, which eliminated problems of rusty water that had occurred in the past. The well was test pumped at 50 gpm with no measurable drawdown. The water is hard but otherwise of good quality.

Average daily water use at the Visitor Center and Museum was computed from records of pumping from the well near the visitor center. These data do not include water usage at the maintenance shop or the employee residence area. Average daily water usage ranges from a few hundred gallons per day in the winter to about 10,000 gallons per day in the summer (Figure 8). The increase in water usage in the summer of 2001 was caused by irrigation of newly planted lawns near the new visitor center during an exceptionally hot, dry summer.

Water usage for the maintenance and eastern housing area averages 900,000 gallons per year during normal years (1996-2000) and about 1,750,000 gallons during dry years (2002-2004). Annual usage for all facilities at the park is about 2,500,000 gallons, or 7.7 acre-feet (AGFO, 2004).

Water Use Immediately Downstream of the Park

Immediately downstream from the park, the Skavdahl Brothers farming operation uses both surface and groundwater for irrigation. The headgate for the Harris-Neece Ditch on the Niobrara River is within the Skavdahl Brothers' inholding, just downstream from the park fee lands. This ditch is permitted for diversion of 9.67 cfs to irrigate 676 acres. From 1995-2003, diversions have ranged from about 1500-2000 acre-feet/year. There are also two irrigation wells to provide supplemental water for irrigation. One of these wells is on the east side of the fence marking the eastern boundary of park fee lands, near the eastern housing area. The other well is further east on the north side of the River Road.

Regular monitoring of water levels in the park's domestic supply well near the maintenance shop will show whether pumping at the nearby irrigation well has a significant effect on the water table in the area. However, it will be difficult to separate water table drawdown from pumping at the irrigation well from effects caused by pumping from the park's water supply well. Previous investigations of the hydrogeology of the area (Bradley, 1956 and Emery, 1966) have shown that there is plentiful groundwater in the area and it is unlikely that the amount of

groundwater pumped from the park wells and the two adjacent irrigation wells will have a significant effect on the hydrology of the area.

Water Quality

An inventory and analysis of water-quality data revealed a shortage of surface-water chemistry data in the study area and a clustering of stations (NPS, 1998). Five of seven water quality monitoring stations were located in the area of the State Highway 29 Bridge near the west side of the park, including one station that accounted for 77% of the 1270 total observations. The station with the majority of the water quality data was operated by the Nebraska Department of Health from 1968-93. None of the seven stations was located outside the park boundary. Without adequate data it is difficult to make definitive statements regarding surface water quality within the study area; however, from the limited available data, water quality generally appears good. Potential contamination sources are mostly limited to agricultural products: pesticides, herbicides, fertilizer, and byproducts contained in surface runoff or irrigation return flows from farmed areas upstream of the park. Four of the seven stations were sampled under the auspices of the LTEM (Long Term Ecological Monitoring) macroinvertebrate monitoring program (Harris and others, 1990). Two of the seven stations were sampled only one time.

Groundwater quality data are sparser than surface water data. Water quality samples are periodically collected from the wells providing public water supplies to park staff and visitors. The only potential groundwater contamination sources are the septic leach fields operated by the park.

The Upper Niobrara White Natural Resources District is conducting a groundwater quality investigation in the Box Butte / Mirage Flats irrigation area to improve the efficiency of irrigated agriculture and to increase public awareness of nonpoint source pollution and ground water contamination. The study area is downstream of the park and will not assess groundwater quality at Agate Fossil Beds.

Dr. Nels Troelstrup of South Dakota State University (SDSU) is developing a monitoring plan for Aquatic Ecosystems in the Northern Great Plains Network (<http://www1.nature.nps.gov/im/units/ngpn/Pages/monitoring.htm>). Aquatic resources at Agate Fossil Beds will be included in this monitoring program.

Geology and Groundwater Resources

The geology and groundwater resources of Agate Fossil Beds and the surrounding area are described by Bradley (1956). Site-specific hydrogeologic conditions are provided in unpublished USGS reports prepared in conjunction

with construction of the park's original water supply well in 1967 (Emery, 1966). The Niobrara River valley is underlain by up to 50 feet of alluvium. The alluvium overlies sand and silt sediments belonging to the Arikaree Group.

The park's water supply wells and nearby irrigation wells are constructed into the Arikaree Group, generally to a depth of 100-200 feet. Yields of 100-1000 gpm are common for wells constructed in the Arikaree Group. The park's original well was drilled to 240 feet deep and tested at 160 gpm for 30 hours resulting in 97 feet of drawdown. The potable water supply well and fire well in the maintenance area were constructed in 1992. Both wells are 180 feet deep. The potable supply well is 6-inch diameter and the fire well is 10-inch diameter. Both wells are screened starting at 90 feet below ground surface. The potable supply well will produce about 140 gpm at a pumping level of 90 feet below ground surface (the top of the well screen). The 10-inch fire well will produce 400 gpm with a pumping level of 76 feet below ground surface.

In general, groundwater in the alluvium along the river is closely interconnected with surface water flow in the river. Water table elevations in the alluvium probably closely mimic stream elevations, with a slight gradient toward the river. Flooding creates opportunities for recharge by infiltration of surface water over large flooded areas, followed by subsequent drainage of the shallow alluvial groundwater to the river. Rainfall and snowmelt provide another source of recharge to the shallow alluvial aquifer. There is a small component of groundwater flow toward the river. Discharge of groundwater to the river maintains baseflow in the stream and generally causes streamflow to increase in the downstream direction. Much of the groundwater in the alluvium probably remains in the alluvium, flowing downstream as a slow-moving underground river. The alluvium acts as a buffer to streamflow, accepting large quantities of recharge during wet periods and slowly releasing the water to the stream during dry periods.

Groundwater in the underlying sediments of the Arikaree Group is recharged by infiltration of rainfall on upland areas. Even though rainfall is low in the area, sandy soils allow rapid infiltration of water, resulting in significant recharge to underlying geologic formations.

In August 2002, a series of streamflow measurements were made through the park in an attempt to identify areas of significant groundwater inflow into the river. (These data are included in the appendices of this report.) The data were inconclusive in identifying the location of significant springs or seeps. The extreme drought conditions of the summer of 2002 may have contributed to the lack of significant groundwater flow to the stream. Alternatively, groundwater inflow to the river under baseflow conditions may be insignificant over the four miles encompassed by the park.

Issues

1. Streamflow gaging

The USGS operated a streamflow gaging station on the Niobrara River, at the Highway 29 bridge, from 1957-91 (Station Number 06454100). The site is near the upstream boundary of AGFO. From 1994-2004 the chart recorder at the gaging station was operated by park staff. However, data collection did not meet QA/QC standards for operating a streamflow gaging station. In FY-03, the USGS was contracted to conduct streamflow gaging at this site to evaluate the stage-discharge rating curve for the site. USGS also conducted repair and maintenance of the chart recorder and associated equipment to make certain that it was in good operating condition.

The charts from the recorder for the period from 1991-2004 were analyzed as part of the research for this report. However, the data have not been published anywhere in the public domain, and other parties will only discover the data by very persistent efforts or blind luck. These data have been published as an unofficial report and a limited number of copies have been provided to the park and Nebraska DNR and placed in WRD files. A copy of the data and hydrographs are included in Appendix 8 of this report.

In the fall of 2004, new equipment was installed to provide a continuous record of streamflow at the site. The gaging station will be operated and maintained by staff from Nebraska DNR. The data will be analyzed and published by DNR in their annual "Hydrographic Report." The digital recording equipment for the site was purchased by NPS.

2. Water table decline from groundwater pumping

Most of the irrigation wells along the Niobrara River are sufficiently distant from the park that they will not affect the water table elevation in the park. Two irrigation wells operated by the Skavdahl Brothers near the eastern park boundary may be an exception. Regular monthly monitoring of the water level in the domestic supply well for the park's eastern housing area and maintenance shop will provide an indication of whether (and how much) pumping groundwater for irrigation affects the water table in the park. Preliminary data (Figure 9) show an annual groundwater level decline and recovery of about 5 feet, but data are insufficient to determine whether this is a natural fluctuation or if it is caused by groundwater pumping from the irrigation wells. Park staff are continuing to make regular groundwater level measurements to allow analysis of this issue.

3. Groundwater/surface water interaction

There may be areas along the Niobrara River within the park where “springs” allow significant quantities of groundwater to flow into the river. If these springs occur in the stream channel, they would not be readily apparent by visual inspection. Spring discharge into the river could significantly change water quality for a short reach of the river, affecting stream biota. Precise measurement of streamflow at a series of locations along the river (a process usually referred to as a seepage run) could identify reaches of the river where significant streamflow changes indicate areas where groundwater is discharging to the river or water from the river is infiltrating into the groundwater system. An initial assessment did not reveal reaches of significant groundwater inflow into the river or seepage from the river into the groundwater system (Appendix 5).

References

AGFO, 2004, *Environmental Assessment to Rehabilitate the Park's Fire Protection, Potable Water Supply, and Water Treatment and Distribution System*, 36 pp.

Bradley, Edward, 1956, *Geology and Ground-Water Resources of the Upper Niobrara River Basin, Nebraska and Wyoming*, U.S. Geological Survey Water-Supply Paper 1368, 67 pp.

Emery, Phillip A., 1966, *Reconnaissance Survey of the Geology and Ground-Water Resources of the Proposed Agate Fossil Beds National Monument, Sioux County, Nebraska*, U. S. Geological Survey unpublished report, 4 pp.

Harris, Mitchell A., Boris C. Kondratieff, and Terence P. Boyle, 1990, *Macroinvertebrate Assemblages and Water Quality in Six National Park Units in the Great Plains*, unpublished, 2 vols.

HKM Engineering Inc, Lord Consulting, Watts and Associates, 2002, *Northeast Wyoming River Basin Plan, Final Report*, Prepared for the Wyoming Water Development Commission Basin Planning Program.

NPS, 1998, *Baseline Water Quality Data Inventory and Analysis, Agate Fossil Beds National Monument*, National Park Service, Water Resources Division, Fort Collins, CO, Technical Report NPS/NRWRD/NRTR-98/151, 112 pp. plus appendices.

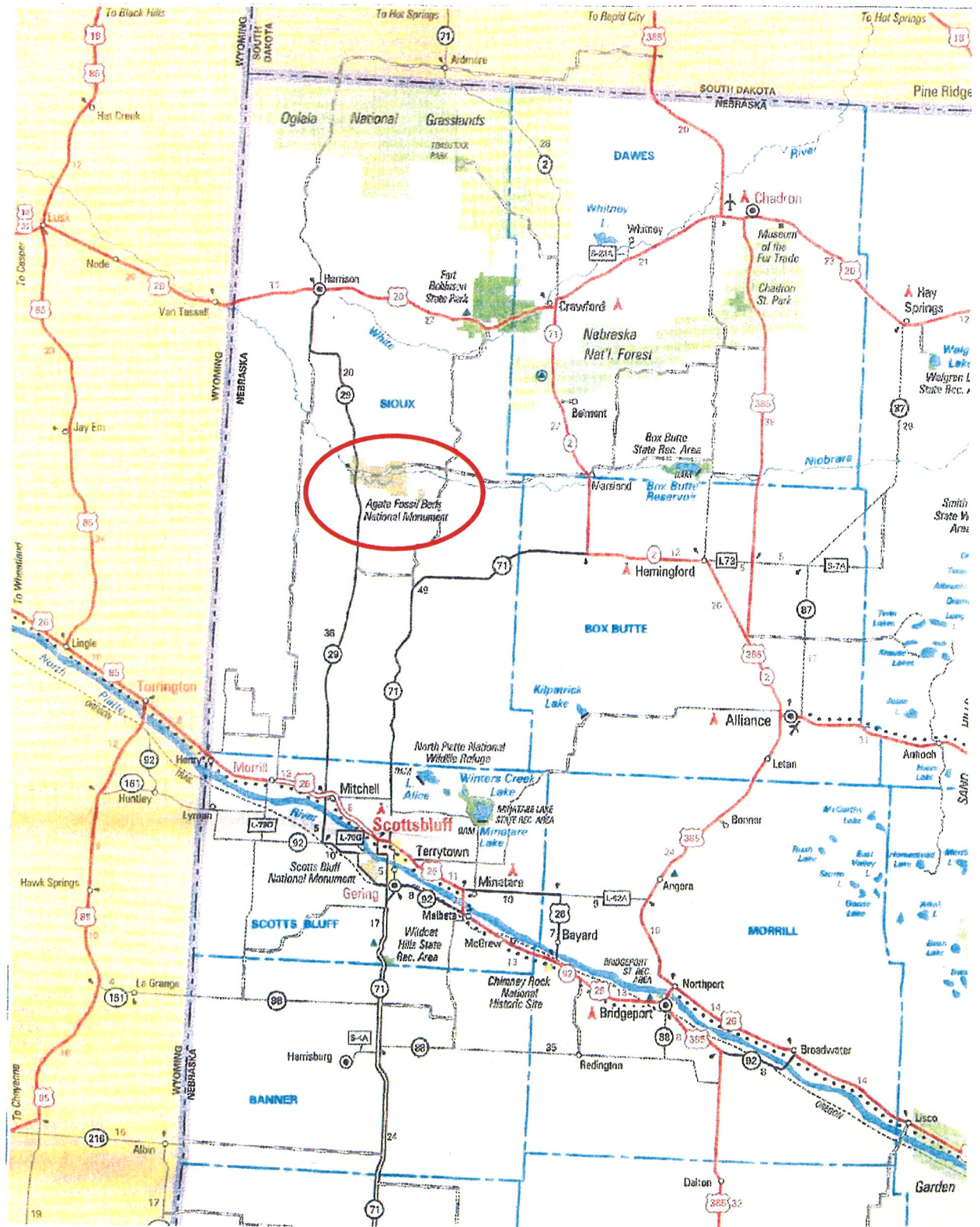


Figure 1. Location of Agate Fossil Beds National Monument in western Nebraska.

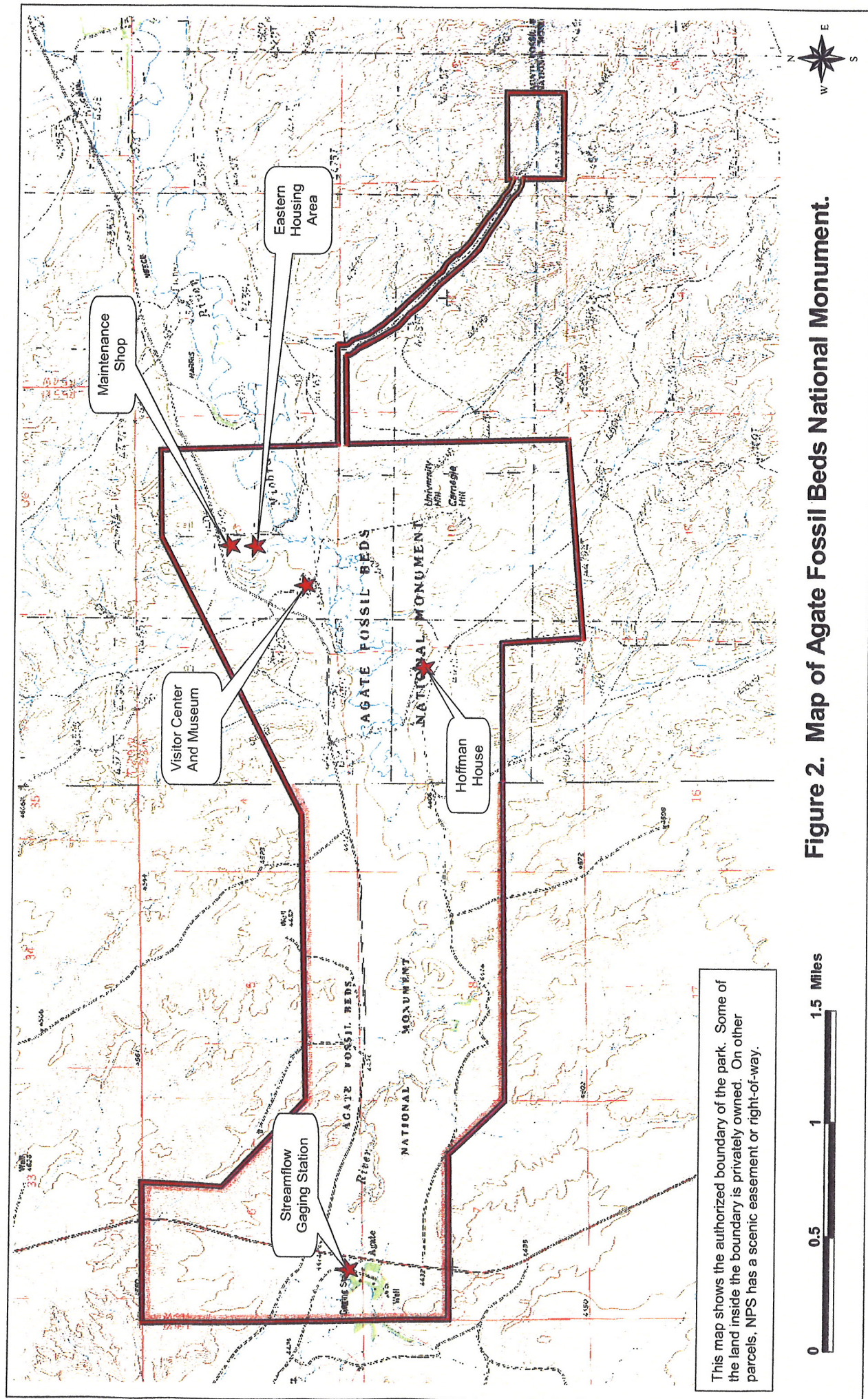


Figure 2. Map of Agate Fossil Beds National Monument.

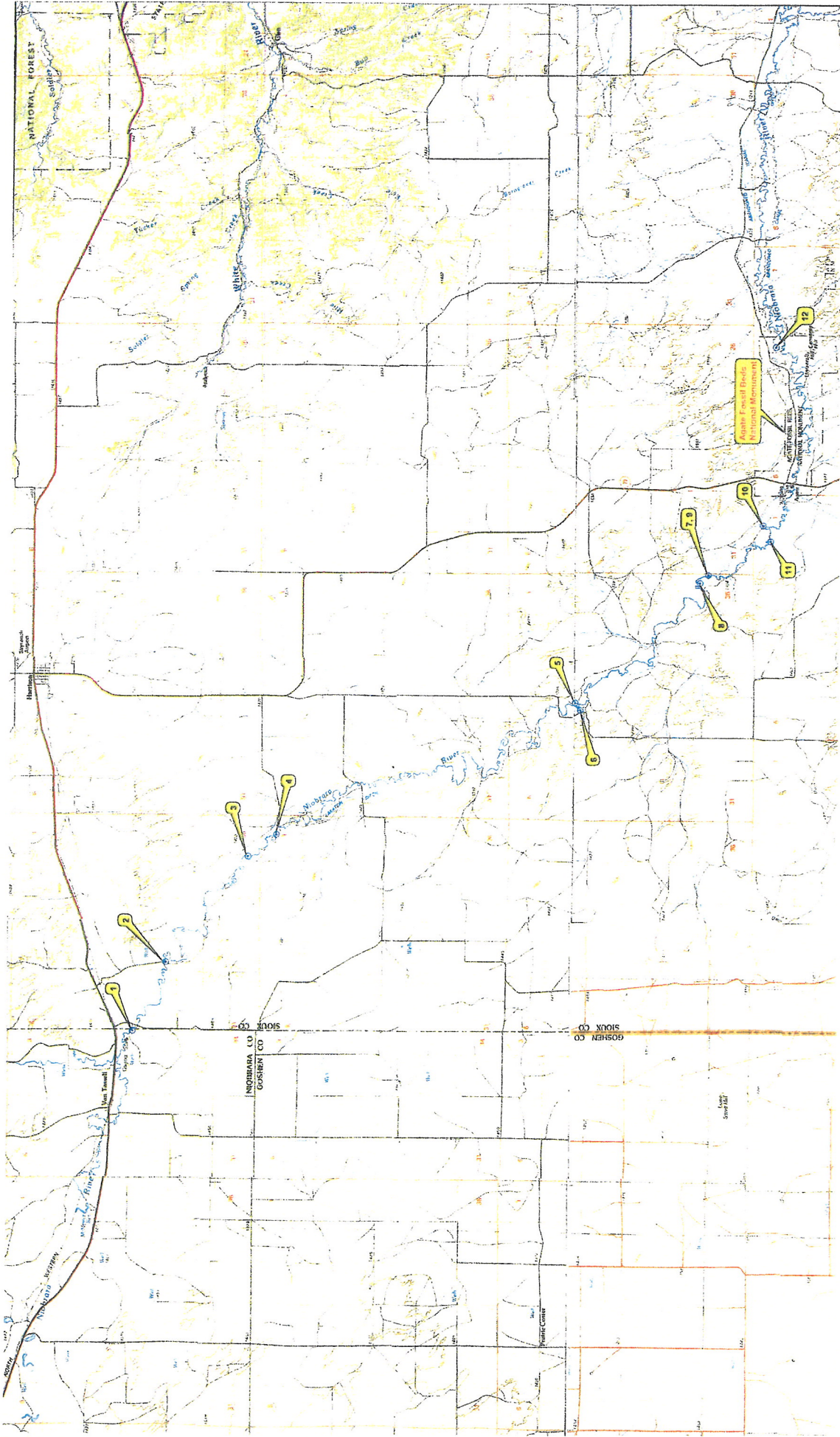


Figure 3. Location of surface water diversions from the Niobrara River.

Map ID numbers correspond to the ID numbers in Table 1

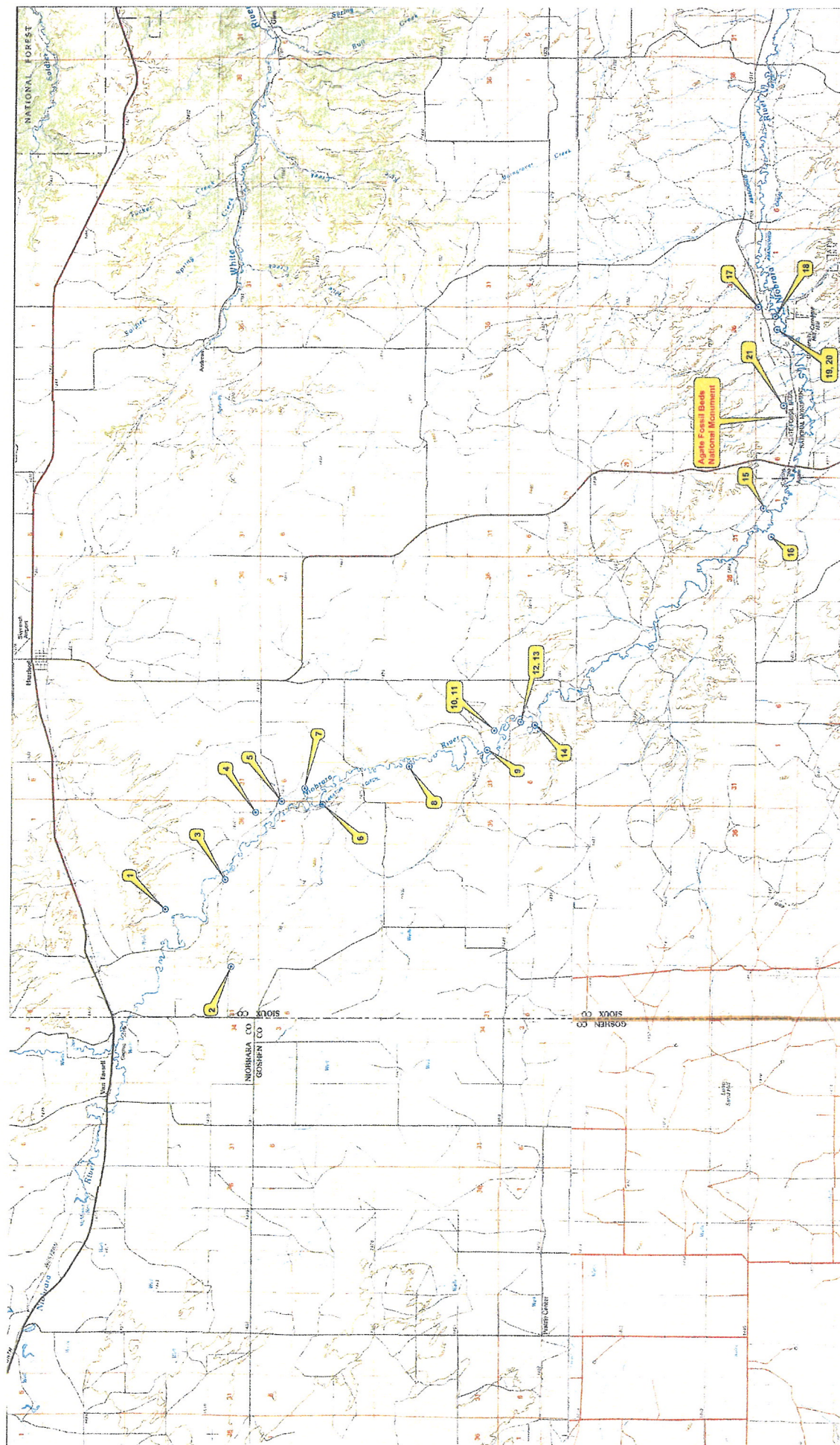


Figure 4. Location of registered water wells along the Niobrara River.

Map ID numbers correspond to the ID numbers in Table 3

Niobrara River at Agate, Nebraska
February 1995 to June 2004

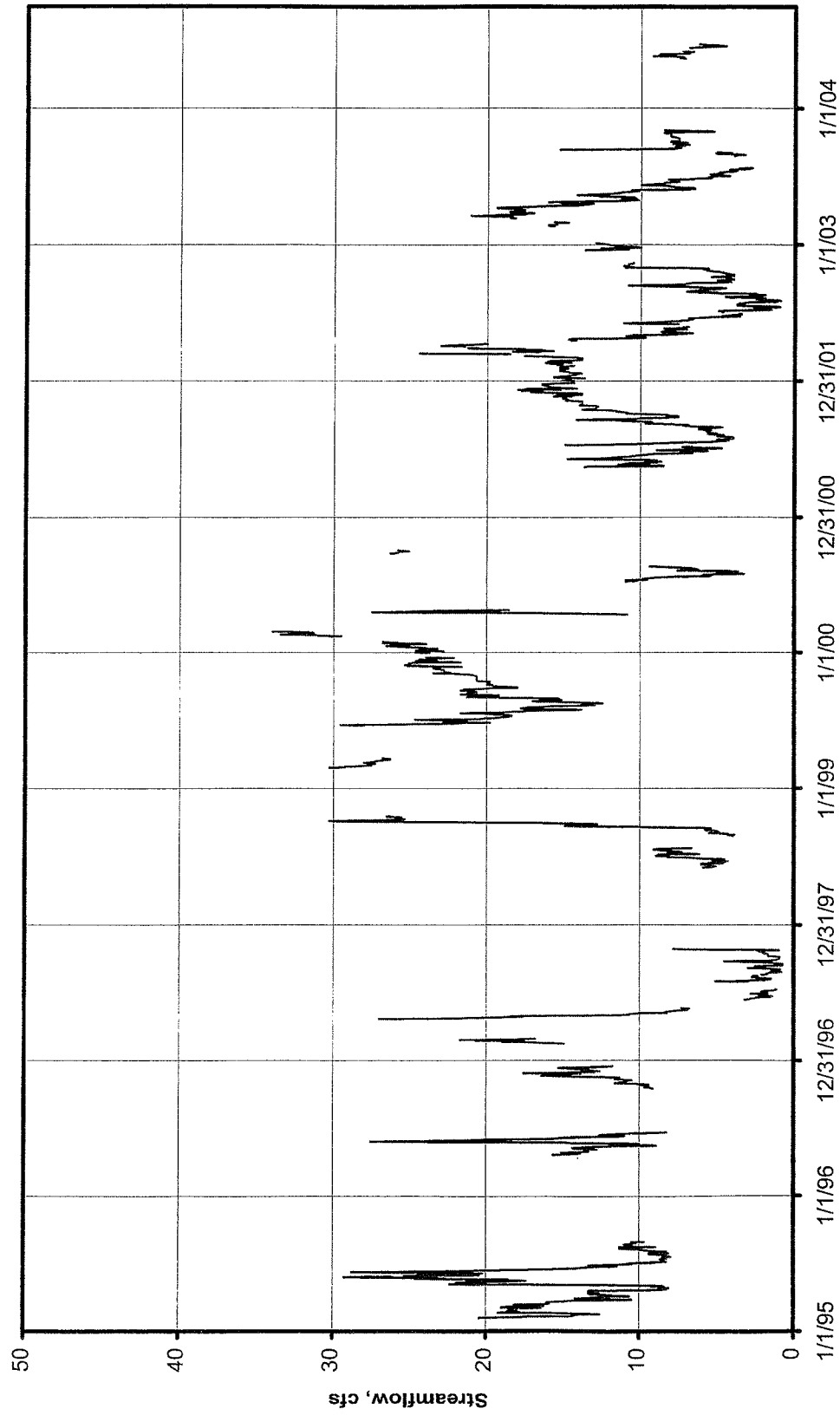


Figure 5. Streamflow in the Niobrara River during the period the gaging station was operated by NPS personnel

Niobrara River at Agate, Nebraska
USGS Station 06454100

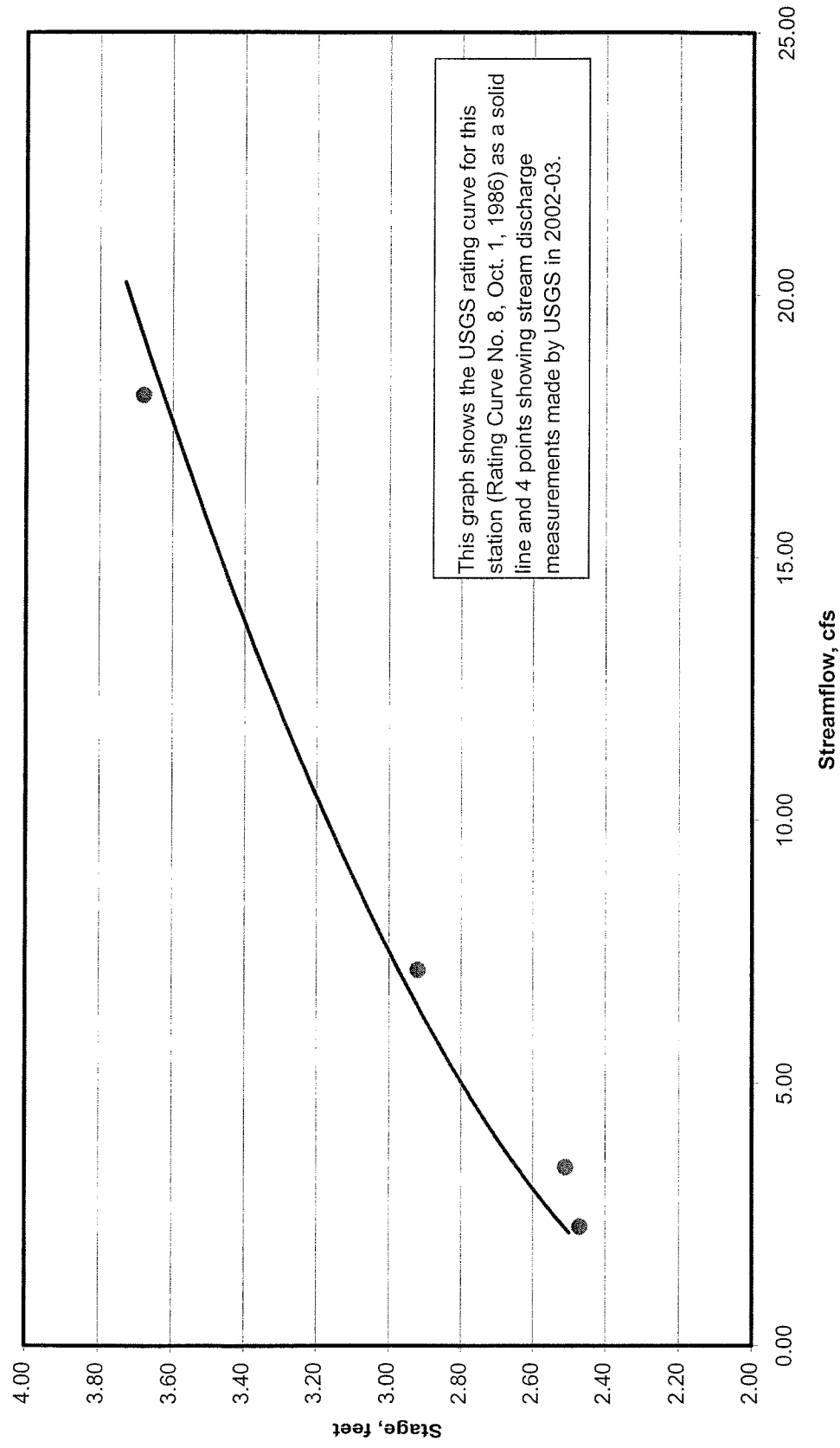


Figure 6. Rating curve for streamflow gaging station on the Niobrara River at Agate, Nebraska.

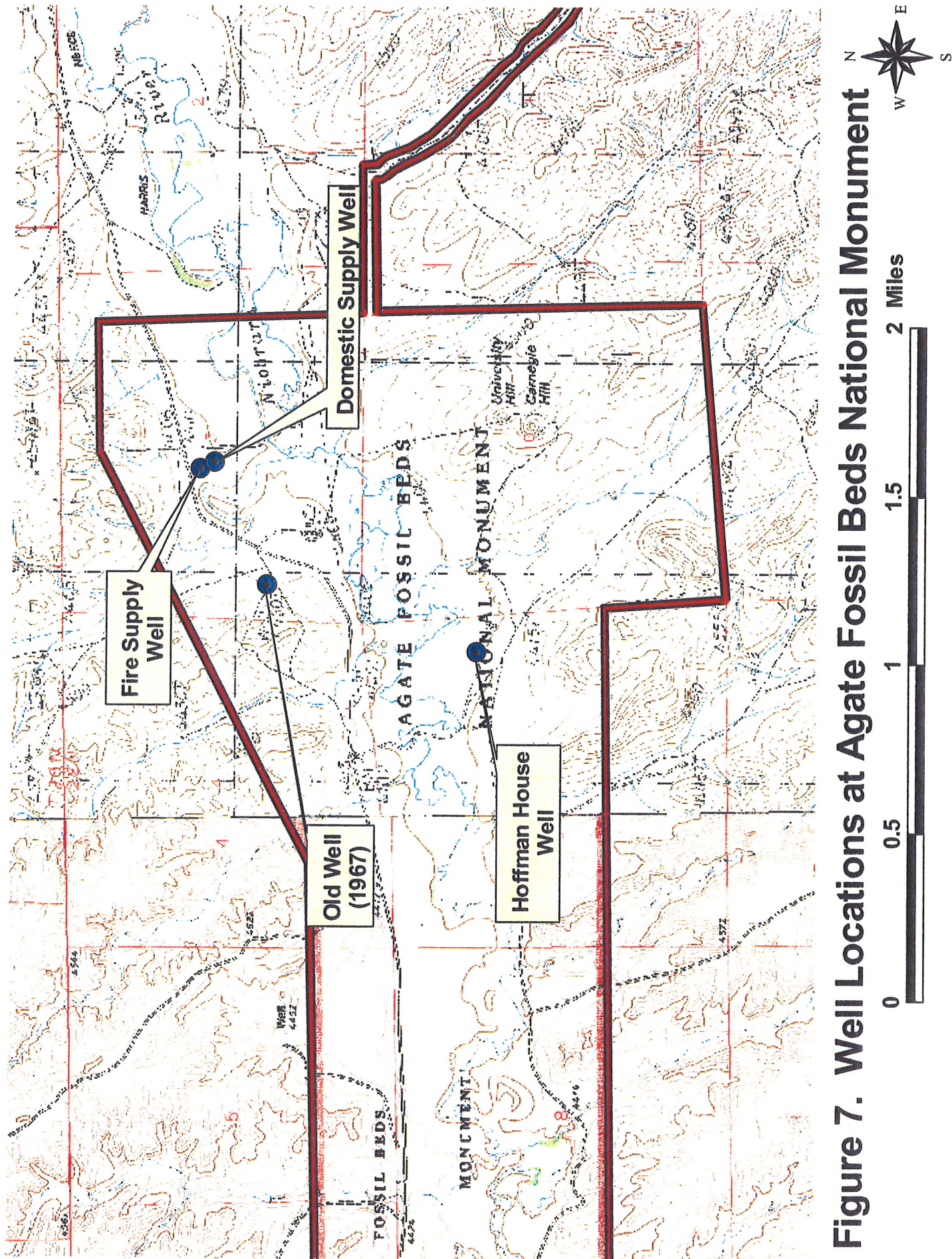


Figure 7. Well Locations at Agate Fossil Beds National Monument

Average daily water use at the Visitor Center and Museum
Agate Fossil Beds National Monument

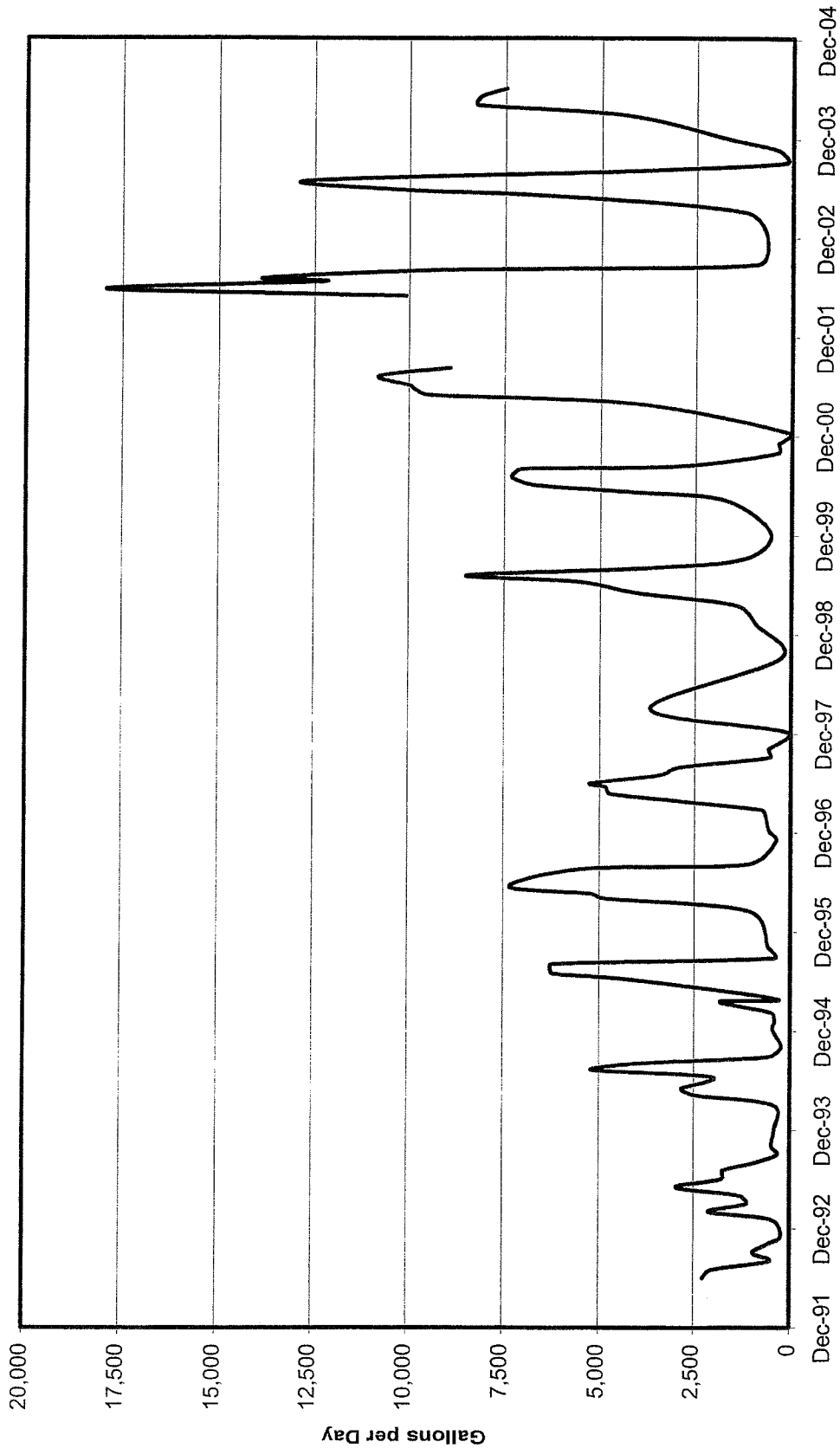


Figure 8. Average daily water use at the visitor center and museum.

Agate Fossil Beds
Potable Supply Well at Maintenance Area

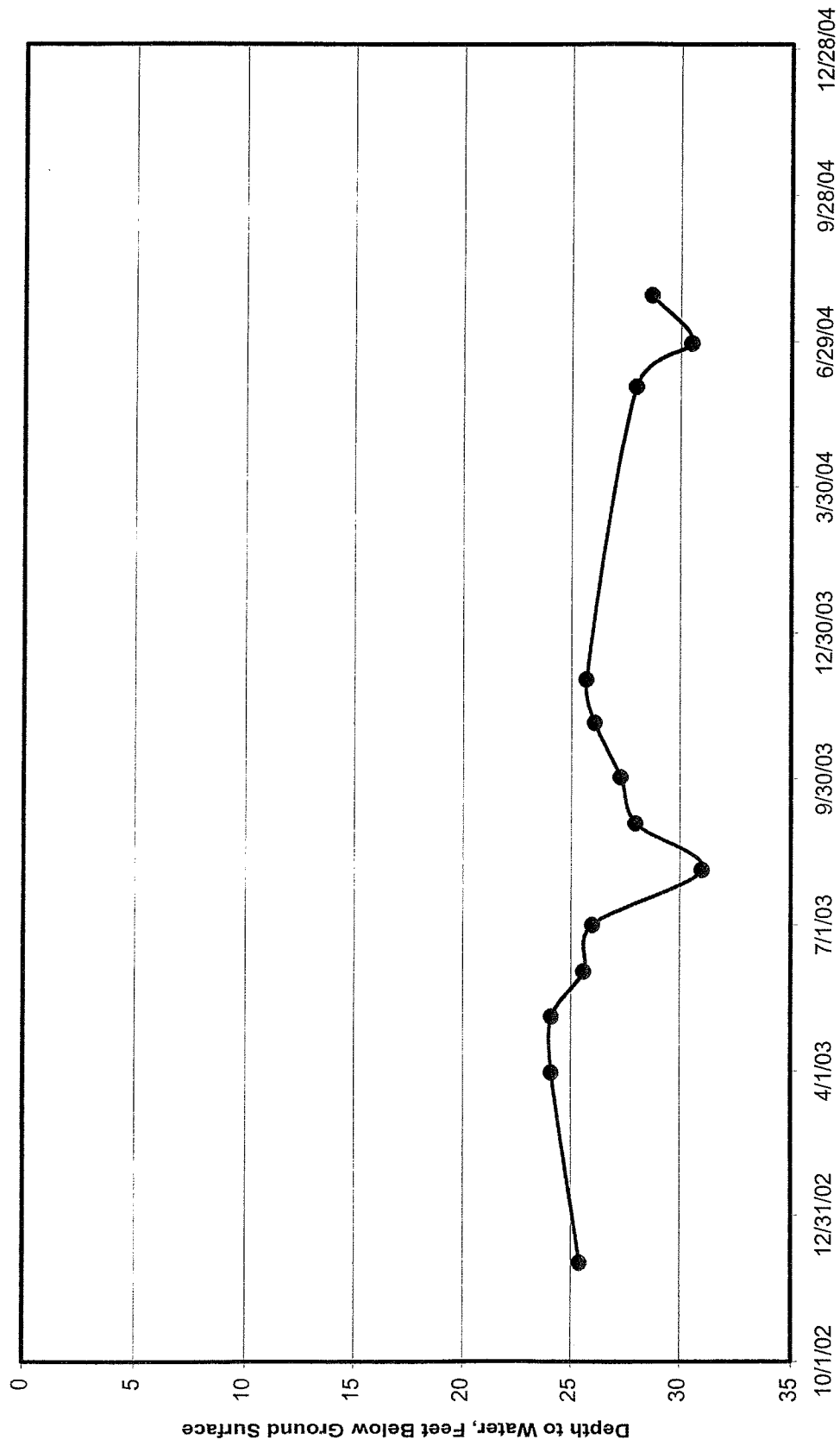


Figure 9. Depth to groundwater measured in the potable supply well in the maintenance area.

Table 1. Surface Water Rights on the Niobrara River from the
Wyoming-Nebraska state line through Agate Fossil Beds National Monument

Map ID Number	Location Twn-Rge-Sec	Priority Date	Docket/ App'l'n Number	CFS	Irrigated Acres
1	31-57-19 Ellicott Hereford Ranch, Biglow-Seymour Canal	6/8/1891	D-510	1.2	83.5
2	31-57-21 Ray Dout Ranch & Cattle, Pumps	6/8/1891	D-510 R	0.96	67.6
3	31-57-35 Howard Juhl, Johnson Canal	5/1/1894	D-511 R, P-243	2.09	146
4	30-57-1 Melvin & Klara Grote, Lakotah Canal	10/1/1883	D-554	5.76	404.5
5	29-56-9 Six Bar Ranch, Earnest Canal No. 2	5/15/1891 3/24/2014	D-514B A1362 R, P-311	2.14 1.46	149.97 102.38
6	29-56-9 Six Bar Ranch, Earnest Canal No. 1	5/1/1885	D-514A, P-397	2.86	189.59
7	29-56-25 Agate Springs Ranch, McGinley-Stover N. Canal	5/1/1887	D-513AR	5.06	354
8	29-56-25 Agate Springs Ranch, McGinley-Stover S. Canal	5/1/1890	D-513BR, T-754	1.34	94
9	29-56-25 Agate Springs Ranch, McGinley-Stover N. Canal and Cook Canal No. 2	5/31/1891	D-980B	0.16	10.9
10	28-56-1 Agate Springs Ranch, Pump	5/1/1887 5/31/1891	D-513AR, P-430 D-980, P-428	1.48 0.52	103.4 36.1
11	28-56-2 Agate Springs Ranch, Cook Canal No. 1	5/31/1891	D-980A	2.31	162.1
Total Upstream of Park				27.34	1904.04
12	28-55-3 William Skavdahl, Harris-Neece Canal	7/1/1892 7/11/1932	D-517 A-2275	7.13 2.54	499 177
Total Downstream of Park				9.67	676

Table 2. Streamflow and Irrigation Diversions from the Niobrara River, acre-feet

WATER YEAR	FLOW AT WYOMING- NEBRASKA BORDER	DIVERSIONS BETWEEN BORDER AND AGATE	DIVERSIONS AT HARRIS-NEECE CANAL
2003	2220	1655	1350
2002	2200	1522	1610
2001	2430	1170	1780
2000	2750	2149	1620
1999	3010	2093	1500
1998	2670	1778	1450
1997	2710	1982	2040
1996	2340	2751	1540
1995	2670	2830	1540

Data were obtained from the annual Hydrographers Report published by the Nebraska Department of Natural Resources. Streamflow is measured at a gaging station at the Wyoming-Nebraska border, about 25 miles upstream from Agate Fossil Beds. Diversions between the state border and the monument are listed in Table 1. The Harris-Neece Canal diversion point is at the downstream boundary of the park fee lands.

Table 3. Registered Groundwater Wells within about 1 mile of the Niobrara River from the Wyoming-Nebraska state line to downstream of Agate Fossil Beds National Monument.

Map ID Number	Owner	Location Twn-Rge-Sec	Completion Date	Registration Number	Pumping Rate, gpm	Irrigated Acres
1	Derrick Keim	31-57-22-SW Center	4/1/1995	G-103502	3	0
2	Mike Wickersham	31-57-32-SENE	6/10/1997	G-094534	70	---
3	Boggs and Hanson	31-57-35-SWNW	6/15/1955	A-007766	---	120
4	Derrick Keim	31/57/36-SWSE	8/5/2003	G-123492	1500	65
5	Blanche Parsons	30-57-01-NESE	3/18/1955	A-007352	2000	200
6	Melvin Grote	30-57-12-SENE	8/1/1976	G-051391	882	200
7	Blanche Parsons	30-56-07-NENW	6/1/1952	A-006658	2000	240
8	Melvin Grote	30-56-19-NWSE	8/1/1976	G-051392	800	200
9	Nature Conservancy	30-56-32-NESW	2/19/1998	G-096226	300	56
10	Nature Conservancy	30-56-32-NWSE	4/2/1998	G-096227	500	92
11	Nature Conservancy	30-56-32-NWSE	2/24/1998	G-096228	200	37
12	Nature Conservancy	29-56-05-SENE	10/8/1975	G-050129	300	70
13	Nature Conservancy	29-56-05-SENE	7/23/2001	G-050129	650	77
14	John Bourret	29-56-05-NESE	7/1/1955	A-008099	---	140
15	James Skavdahl	28-56-01-NENW	11/13/2003	G-125399	---	100
16	James Skavdahl	28-56-02-SENW	5/15/1995	G-086641	2	---
17	Skavdahl Bros.	28-55-03-NENE	11/3/1978	G-096055	950	80
18	Skavdahl Bros.	28-55-03-SWNE	10/10/1978	G-096056	600	180
19	National Park Service	28-55-03-SENW	10/8/1992	G-079952	300	---
20	National Park Service	28-55-03-SENW	10/1/1992	G-079953	80	---
21	Buckley Bros.	28-55-05-NWSE	3/15/1955	A-007276	---	150